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A comparative study on the formation of porous membranes with crystalline and amorphous glassy polymers

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In the last decades, several polymers have been investigated and are commercially used in the preparation of porous membranes for water treatment and other applications [1]. During the membrane formation, two main solidification processes may occur, according to the nature itself of the polymer: crystallization and vitrification [2, 3].

Among others, the semi-crystalline polyvinylidene fluoride (PVDF) and the glassy amorphous polyethersulfone (PES) have gained large importance in the field of low pressure water filtration and in the emerging sector of membrane bioreactors for waste water treatment [4, 5].

Both these polymers are moderately hydrophobic and readily soluble in common aprotic solvents, with similar non solvents and additives used during the membrane manufacturing. These characteristics make them ideal candidates to elucidate the different solidification processes, undergoing the production of MF/UF membranes with controlled pore size and morphology using phase inversion techniques.

The aim of this preliminary study is the comparison of the membrane formation and the resulting membrane characteristics of two Solvay high molecular weight grades, PVDF Solef® 1015 and PES Veradel® 3000 MP. In particular, we have revisited the effect produced by different coagulation baths (from soft to harsh) in non-solvent induced phase separation, under other wise identical preparation conditions.

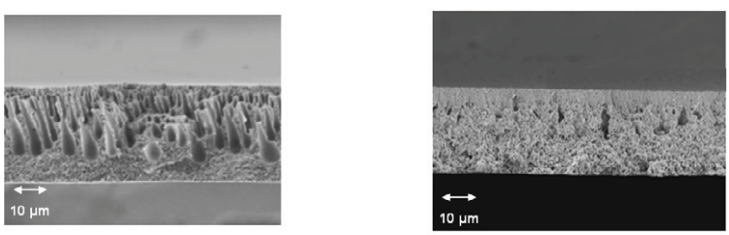

Fig. 1: Veradel@ 3000 MP (left) and Solef® 1015 (right) structure comparison using SEM micrographs of the fracture. Both the membranes were prepared using the same preparation conditions.

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Both polymers show finger-like structure and spongy portions when coagulated in water, while strongly different membranes and morphologies are obtained when “softer” non-solvents (alcohols) are used: PES membranes show a cellular structure and dense skin, while PVDF leads to membranes with a globular morphology and open surface structure. Despite these differences, dense skin can be avoided for both polymers using solvent-rich baths.

The effect of the coagulation bath on the solid state properties of the membrane polymer has also been investigated. It is suggested that the relative kinetic of phase-separation and solidification, together with the physical nature of the solid polymer, determines the final membrane properties.

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